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HOW DO TAX EVASION AND ADMINISTRATION AFFECT THE COST OF TAX FUNDS?

A Dissertation

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Doctor of Philosophy

by

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BIOGRAPHICAL SKETCH

Wetang Phuangsup was born in November 1967 in Udonthani, Thailand. He obtained his Bachelor of Engineering from Chulalongkorn University, Thailand in 1991. After that, he came to the United States to pursue his graduate study. After receiving Master's Degree in Applied Economics from the American University in 1993, he joined the Ph.D. program at the Department of Economics in the fall of 1994. He completed his Doctoral degree in August 1999.

To my parents, my sister and friends.

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TABLE OF CONTENTS

LIST OF TABLES

Chapter 1

INTRODUCTION

Firms can raise funds by issuing equities, borrowing from banks or individuals or using a combination of these methods. Different means or structures to raise funds will have different costs and the costs may vary widely. Hence, it is crucial to find a proper measure for calculating the cost of capital raised by all major means and structures. To calculate a company's cost of capital, any measure that fails to take into account major fund raising instruments, such as borrowing from banks would be highly misleading. For example, if a company cost of capital theory ignores the existence of the debt instrument, the theory would not be very useful.

Similarly, a government can raise more tax revenues by increasing tax rates or by employing non-tax rate instruments such as changing the tax administration and penalty structure. Different means or structures to raise tax funds may have significantly different costs. Hence, it is important that a comprehensive theory of the cost of tax funds incorporates all major tax instruments in order to properly measure the cost of tax funds. In fact, the existing literature on the cost of tax funds raised by using non tax rate instruments is sparse[1], although in practice

[1] Although there are a large number of papers studying optimal taxation with evasion and optimal tax administration and penalty structure, such as Slemrod and Yitzhaki (1987), Yitzhaki (1987), Kaplow (1990) and Cremer and Gahvari (1994), only Fortin and Lacroix (1994) and Slemrod and Yitzhaki (1996) derive measures for the cost of tax funds raised by using non tax rate instruments.

non-tax rate instruments are an integral part of a tax system. For example, in the fiscal year 1987, the Internal Revenue Service reported that about \$84.9 billion, or 20% of tax liabilities were not reported. Further, according to Malanga (1985) and Slemrod (1992) IRS enforcement actions produced about \$32 billion, and each additional budget dollar allocated to IRS would return on the order of ten dollars in increased revenues. Non-tax rate instruments are, of course, not any less essential in developing countries. Casanegra de Jantshcher (1990) argues that in developing countries, "tax administration is tax policy." As a result, any cost of tax funds theory that fails to consider non-tax rate instruments may have limited applicability.

The purpose of this paper it to contribute to the concept of the cost of tax funds by recognizing the existence of non-tax rate instruments under the setting of uncertainty. Using the concepts of the marginal cost of funds and tax evasion, we try to measure the cost of tax funds raised by using tax rates and major non-tax rate instruments: auditing and fine rate in particular. Also, we study extensively the changes in the cost of tax funds which result from variations in tax parameters under the setting of uncertainty.

Our contributions are threefold. First, this thesis is a pioneer in constructing the measure of the cost of tax funds of non-tax rate instruments and of tax rates under the influence of non-tax rate instruments. Second, the thesis provides an analysis of the basic properties of the derived measure and, in particular, the changes in the cost of tax funds which result from variations in the tax rate and non tax rate parameters. Finally, this study gives estimates of the costs of tax funds of relevant tax instruments for the U.S. economy.

This chapter is organized as follows: in the first section, we explain the definitions of non compliance, tax avoidance and tax evasion. In the second section, we

discuss marginal cost of funds and describe why tax administration and evasion are crucial concepts in the study of marginal cost of funds. In the third section, we state the motivation, purposes and contributions of this thesis. In the last section, we provide organization of the rest of this thesis.

1.1 The Definitions of Non-Compliance, Tax Avoidance and Tax Evasion

Let's start this section by discussing the definition of compliance. We follow the definiton of tax compliance as put forward by the panel on Taxpayer Compliance Research:

> "Compliance with reporting requirements means that the tax payers file all required tax returns at the proper time and the returns accurately report tax liability in accordance with the Internal Revenue Code, regulation and court decisions applicable at the time the return is filed. (Roth et al (1989) p.12)"

Accordingly, noncompliance occurs whenever a tax payer fails to comply with related legal requirements. Noncompliance may be arise from a variety of reasons regardless of the tax payer's intention and motivation; the tax payer's noncompliance is not necessary a willful act. For example, if a tax payer carelessly reports his tax liability as less than the accurate amount, then his act is classified as "noncompliance." In this paper, when a tax payer reports his tax liability as less (more) than the accurate amount as defined by related laws and regulations, we say that he has underreported (overreported) tax liability.

Let's further clarify two more terms, tax evasion and tax avoidance. The most widely-used definition is that of Oliver Wendell Holmes:

> "When the law draws a line, a case is on one side of it or the other, and if on the safe side is none the worse legally that a party has availed himself to the full of what the law permits. When an act is condemned as evasion, what is meant is that it is on the wrong side of the line..."(Bullen vs Wisconsin (1916) 240.U.S. 625 at page 630)."

In other words, tax evasion occurs when the act is illegal while, in contrast, tax avoidance is not illegal. Of course, in practice the distinction between tax evasion and avoidance is seldom clear.

1.2 Issues in Marginal Cost of Funds, Evasion and Tax Administration

Literature on tax evasion has flourished since the breakthrough papers by Allingham and Sandmo (1972) and Srinivasan (1973). Also literature on the marginal cost of funds has appeared in economic journals such as Browing (1976) and Stuart (1984). However, only recently has the issue of the marginal cost of funds been studied along with tax administration and evasion. The few studies in this area are Mayshar (1991a), Fortin and Lacroix (1994) and Slemrod and Yitzaki (1996). Slemrod and Yitzhaki (1996) urge that the concept of the marginal efficiency cost of funds[2] studied together with compliance and tax administration issues, is an appropriate approach to evaluate tax reforms. Further, Slemrod and Yitzhaki (1998) argue that tax avoidance, evasion and administration are central concepts in public finance. After discussing the concept of the marginal cost of funds, this section follows the direction of Slemrod and Yitzhaki (1996) and Slemrod and Yitzhaki (1998), to argue that tax evasion and administration are crucial

[2]According to Slemrod and Yitzhaki (1996), the concept is slightly different from MCF since efficiency considerations are separated from distributional issues.

concepts in the study of the marginal cost of funds.

1.2.1 What is the Marginal Cost of Funds and Its Implications?

When a public project is financed by a distortionary tax, its real cost to society is not simply the cost of required revenues in monetary terms. This is because of the distortionary effects of tax on the economy. The concept of the marginal cost of funds (MCF) is to measure the social welfare cost (or real cost) of funds, taking into account the distortionary effects of such a tax.

There are two main applications of the concept of the marginal cost of funds. First, the MCF can be applied to the concept of cost-benefit analysis, which is mostly used in the study of project evaluation. The MCF helps to determine the real cost of funds used to finance a project. For example, suppose an infrastructure project would have benefits of \$110 million, and a direct cost of \$100 million. If the project will be financed using tax revenues, the cost-benefit analysis has a criteria that the program is economically feasible if the MCF is smaller than 1.1.

Second, the MCF is used in the study of tax reform. The MCF can help to determine the welfare improving direction of tax reform. The theory of tax reform suggests that a tax system is optimal when MCFs of all tax instruments are equal. Accordingly in practice, the welfare improving direction is the one that employs greater use of tax instruments with a lower MCF and less use of the instrument with a higher MCF. For example, suppose the MCF of an apple tax is 1.5 while the MCF of ice cream tax is 1.2, the tax reform direction is to reduce the apple tax while increasing the ice cream tax.

1.2.2 Why Should Tax Evasion and Administration Be an Integral Part of a Study of the Marginal Cost of Funds?

Most economic theories of taxation assume that tax liability can be collected free of costs. Furthermore, most theories presume that people report truthfully so that penalty structures are irrelevant and there is no tax evasion. However, these assumptions are inconsistent with economic reality. For example, from the tax years 1973 through 1992, the magnitude of tax evasion increased from $22.7 billion to $95.3 billion, or approximately 17.3% of tax liabilities in 1992. A survey by the IRS reveals that 40% of U.S. households underpaid their taxes for the 1988 tax year. Furthermore, the cost of tax collecting was about 10% of the tax revenues[3]. How many people would pay taxes at all if there were no penalty on tax evasion? Slemrod and Yitzhaki (1998) express that:

> "We (Slemrod and Yitzhaki) believe that the consideration of tax evasion, avoidance and administration is essential to the positive and normative analysis of taxation, and that many aspects of observed tax policy make no sense without such consideration, suggesting that those issues do play a major role in the formulation of tax policy".

Blough (1952, p.146) has a similar view on the issue:

> "It is tax policy in action, not simply the wording of the statute, that determines how much the taxpayer must pay, and the effects of the payment. Knowledge of the statute is only a start in knowing a tax system. The interpretations placed on language by administrators and courts, simplicity and understandability of tax forms, the competence

[3] See the Internal Revenue Service (1990, 1996).

and completeness of audit, the vigor and impartiality of enforcement, and the promptness and finality of action all influence the amount of revenue collected, the distribution of the tax load, and the economic effects of the tax".

As argued before, the issues of tax evasion and administration are crucial to the economics of taxation. In particular, these issues are essential in the study of the marginal cost of funds. The traditional marginal cost of funds theory, which tries to measure the cost of tax funds, assumes that tax penalty structure and administration do not matter. In reality, this is untrue. Under different penalty structures and administrative schemes, the costs of tax funds could vary substantially even if the tax funds are raised from the same tax base and at the same tax rate. Altering the penalty structure or administrative strategies while keeping tax rate unchanged would increase (or decrease) tax revenues. For example, the Internal Revenue Service commissioner claimed that each additional budget dollar allocated to the IRS would return on the order of ten dollars in increased revenues. Ignoring such reality, any conclusion drawn from the traditional measurement is subject to question.

1.3 Motivation, Purposes and Contributions

1.3.1 Motivation and Purposes

This thesis is motivated by the following considerations:

1) The significance of the concept of the marginal cost of funds.

2) The importance of the issues of tax evasion, administration and penalty structures for the concept of the marginal cost of funds. Given the considerable reality of tax evasion and costly administration, any cost of tax funds concept

that does not take into account these factors could be misleading.

3) The paucity of existing literature providing satisfactory measures for cost of tax funds of non-tax rate instruments. Non-tax rate instruments such as the number of auditors could be employed to increase the effectiveness of the tax system and to raise more tax revenues. So far, only Fortin and Lacroix (1994) explicitly derive a model to raise funds: however, there is room to improve their model.

4) No existing study has attempted to analyze the influence of non-tax rate instruments on the traditional MCFs. Although there are three papers[4] that study the concept of marginal cost of funds along with tax evasion and costly administration, none has studied the changes in MCFs which result from variations in tax rate and non-tax rate parameters under the setting of uncertainty.

5) No existing literature derives proper models that allow the study of the impact of attitudes toward risk on MCFs with tax evasion and costly administration. Although Fortin and Lacroix (1994) explicitly constructed the first MCF models for probability of detection and fine rate. their models are in limited use when the risk issue is of concern[5] .

The purpose of this paper is to contribute to the concept of the cost of tax funds by recognizing the existence of non-tax rates instruments under the setting

[4]The only three papers are Mayshar (1991a), Fortin and Lacroix (1994) and Slemrod and Yitzaki (1996).

[5]This thesis follows Allingham and Sandmo (1972) by using portfolio approach with one sector. The approach allows people to evade tax liability by underreporting their income. Differently, Fortin and Lacroix (1994) assume two sectors, evadeable and non evadeable. People can evade their tax liability by allocating their labor between non-evadeable and evadeable sectors. Under the two sectors setting, a rise in tax rate will always increase the labor supply in the evadeable sector. Under one sector, attitudes toward risk play a major role in determining the signs, which may be negative, and levels of labor supply and evaded income. In responding to a rise in tax rates, labor supply may rise or fall. Hence this approach is more flexible and consistent with empirical facts. Under two sectors, MCFs of tax rate and fine rate are always greater than one, while those under one sector can be either greater or smaller than one. See Chapter Four for a discussion of attitudes toward risk and their impact on MCFs.

of uncertainty. Using the concepts of the marginal cost of funds and tax evasion, we try to measure the cost of tax funds raised by using tax rates and major non tax rates instruments, auditing and fines in particular. Also, we study extensively the changes in the cost of tax funds which result from variations in tax parameters under the setting of uncertainty.

1.3.2 Contributions

Our major contributions are threefold.

1) This thesis is a pioneer in constructing the measure of cost of tax funds of non tax rate instruments and of tax rates under the influence of non-tax rate instruments. This will contribute to the concept of MCF and, in turn, will improve the concepts of cost-benefit analysis and tax reform.

2) We provide an analysis of the basic properties of the derived measure and, in particular, the changes in the cost of tax funds which result from variations in tax rate and non tax rate parameters.

3) We estimate the costs of tax funds of relevant tax instruments for the U.S. economy. This is the first attempt to estimate the cost of tax funds of non tax rate instruments for the U.S. economy.

By recognizing the existence of non-tax rate instruments, this thesis makes the concept of the MCF more relevant to the real world and more meaningful for tax policy analysis. In practice, tax administrators and policy-makers deal with non-tax rate instruments, at least, as often as they deat with tax rates. For example, they must justify an increase (or decrease) in the number of tax auditors. Traditional cost-benefit analysis alone is not comprehensive enough to evaluate such a proposal. Assuming a net positive benefit of the project, the cost-benefit analysis would suggest increasing the number; however, a tax reform analysis might

suggest something else. If we can calculate and compare the MCFs associated with all potential tax instruments, including the number of tax auditors, the tax reform analysis might recommend employing higher fine rate or other tax rates while reducing the budget for auditors.

Our models are particularly useful for developing countries where tax evasion is substantial. The more evasion and the larger the underground economy, the less relevant the traditional models will be.

It is also worth pointing out what we will *not* discuss.

1) This is not a study of tax reform of tax rates. For simplicity, we assume that there is only labor income tax in the economy.

2) This is not a study of an optimal tax system. There is no attempt to find characteristics of an optimal tax system with the existence of non-tax rate instruments. In other words, this is not a study of an optimal auditing and penalty structure.

3) We do not recognize different forms of tax administration, such as private or public tax administrators. This paper incorporates administrative costs into the model, but not administrative forms, and thus only changes in administrative costs would affect the models.

4) We do not consider all non-tax rate instruments, but limit our focus to auditing and fine rate.

5) This thesis does not take into account influences of social norms, such as fairness.

1.3.3 Organization of the Thesis

The next chapter includes a literature review and a discussion of empirical issues of tax evasion. In Chapter Three, we derive a simple model of the marginal cost

of funds. The model may be called "marginal cost of funds with tax evasion and costly administration." In Chapter Four, we discuss some related theoretical issues and basic properties of the derived models. Under the setting of uncertainty, attitudes toward risk play a major role. We show that assumptions about attitudes are crucial determinants of of people's behavior and of MCF models. At the end of the chapter, numerical simulations are performed and their results are discussed. In Chapter Five, we apply our models to measure MCFs of the U.S. economy. After estimating the MCFs of the U.S., this paper discusses the numerical results and compares them to those of existing literature.

Chapter 2

LITERATURE REVIEW AND EMPIRICAL ANALYSIS

In this chapter, we review literature on tax evasion and then provide a descriptive analysis of related empirical studies. We organize this chapter as follows. In the first section, we review theoretical studies of tax evasion. Since there is a broad range of theoretical literature on tax evasion, we focus on particularly recent or relevant literature. In the second section, we discuss the empirical methodology of tax evasion and compliance. In section three, we discuss empirical results and some data concerns. Given the broad range of the issues, we put more emphasis on studies of evasion and tax rate, probability of detection and fines.

2.1 Literature Review of Theoretical Studies in Tax Evasion

In this section, we review the theoretical issues in tax evasion literature. Tax evasion literature can be classified into two groups. The first group focuses on an individual's compliance behavior and tries to explain how an individual would respond to a given aspect of public policy (tax rate, auditing and fine). After introducing and dicussing standard models and results, we extend the models by

adding labor supply[1]. The second group tries to find an optimal enforcement policy (auditing and fine), and hence focuses primarily on the role of enforcement agent, the IRS in particular.

For the first group, the widely-used methodology is the portfolio choice approach, which considers tax evasion as a decision under uncertainty. The earliest formal analyses of evasion as a decision with risk were given by Allingham and Sandmo (1972), Srinivasan (1973) and Yitzhaki (1974). Basically, the problem can be considered as an individual's optimal decision given a set of parameters (1) income tax rate, (2) probability of detection, (3) fine or penalty rate, (4) income level and (5) attitude toward risk. An average individual is considered to be a gambler who tries to maximize her expected utility by reporting the amount of taxable income to a tax authority. The amount of declared taxable income can be considered as a demand for risky assets, with a high return if the unreported goes undetected and a low return when the unreported is detected by the authority. The three papers are different in the structure of the punishments; Srinivasan imposes a risk neutrality assumption.

Concerning an individual's compliance behavior, the main findings from the existing literature can be summarized as the following:

1) Tax rate and tax evasion can have positive, negative or indeterminated relationships, depending on assumptions. A rise in tax rate may increase or decrease evasion or have indeterminate result. As shown by Balassone and Jones (1998), depending upon attitude toward risk and penalty structures, tax rate and tax evasion can have positive, negative or indeterminated relationships[2]. According

[1]There are several more ways to extend the standard models using portfolio approach. For example, Gordon (1988) incorporates guilt and social norms to the tax evasion models and Cowell and Gordon (1987) demonstrate the impact of public goods on evasion decisions. See Myles (1995) for a more comprehensive survey.

[2]Allingham and Sandmo show that under DARA when the penalty for tax evasion fell on

to Balassone and Jones (1998). if a penalty is imposed on evaded income with Increasing Absolute Risk Aversion (IARA) or Constant Absolute Risk Aversion (CARA) assumption, a rise in the tax rate will increase evasion. However, with the same penalty structure and Decreasing Absolute Risk Aversion (DARA) assumption, a rise in the tax rate will have an indeterminate effect on tax evasion.

2) Fines and probability of auditing both have a negative impact on tax evasion. This result has been supported by all papers, including empirical studies. For example, Allingham and Sandmo (1972) and Yitzhaki (1974) show theoretically that a rise in the probability of auditing and fines will decrease the level of tax evasion. Witte and Woodbury (1985) find empirical support from TCMP and an econometric analysis and Friedland, Maital and Rutenberg (1978) and Becker, Buchner and Sleeking (1987) find evidence to support the theoretical analysis by using laboratory experiments.

3) Income level and evasion have an indeterminate relationship. The relationship might be positive, negative or neutral, depending on a certain risk assumption: DARA, CARA or IARA. The results from empirical studies are indeterminate. Spicer and Lundstedt (1976) employing an interviewing survey and econometric analysis, reveal that an increase in income reduces evasion. In contrast, Becker, Buchner and Sleeking (1987), using a laboratory experiment suggest that income level has a positive effect on evasion.

The portfolio approach can be extended in several ways. However, we only discuss the case when labor supply is added to the standard models. Anderson (1977) and Pencavel (1979) endogenize individual income by adding labor supply to the problem of individual evasion. They try to study the effect of tax and penalty

evaded income, a rise in tax rate might increase, decrease or have no effect the level of evasion. See Chapter Four for further discussion on issues related to attitude toward risk with tax rate and tax penalty structures.

structures on labor supply and evasion decisions. Instead of one sector, Cowell (1981), Sandmo (1981) and Watson (1985) assume two or more sectors, formal and informal(s), to which people can supply labor to any of them. Depending on the assumptions, the findings from the literature are inconclusive. According to Sandmo (1981), a rise in tax rate only increases evasion and labor in the informal sector. This thesis, like Anderson (1977), shows that, depending on assumptions, the rise might increase, decrease or leave unaltered evasion and labor supply. This result comes as no surprise. Without considering tax evasion, Hausman (1985) demonstrates that the effect of tax rate on labor supply is indeterminate; it is expected that allowing evasion would not change the result.

For the second group, optimal auditing and penalty is the focus. Here, the probability of auditing is endogenized and the focus is on the relationship between the tax authority, the IRS, and taxpayers. The most widely used methodology is the principal-agent framework.

Reiganum and Wilde (1985), Scothmer (1986), Border and Sobel (1987) and Mookherjee and Png (1989) use a principle-agent framework to analyze the issues. In most case, the tax agent, the IRS, is assigned as the principal and the tax payers as the agents. The principal asks the agents to report their level of taxable income and under imperfect information, the principal commits to an audit schedule that depends on reported income.

Cremer, Marchand and Pestieau (1990) and Sanchez and Sobel (1993) allow the government to be another actor. The government needs to maximize its objectives by selecting a tax policy (tax rate and penalty) and a tax-collecting budget. Given the budget, the IRS designs an optimal audit schedule to maximize tax revenues from tax payers. The taxpayers need to maximize their income after taxes and penalties.

2.2 Descriptive Analysis of Evasion and Non-compliance

Tax evasion, by its nature, is not easy to measure. Nonetheless, according to Slemrod and Yitzhaki (1997) and Myles (1995), three majors empirical approaches have been attempted. The first approach uses data on measurable quantities such as components of national income accounts and income reported to the Internal Revenue Service (IRS). The second approach conductes laboratory experiments. The last approach uses survey or interview data.

The first approach uses aggregate data on measurable quantities to estimate the extent of tax evasion[3]. According to Molefsky (1982), if goods produced in the regular economy are consumed as part of an underground economy, the value of those goods will undoubtedly be in the GDP: however, the added value that results from the underground activity will most likely be omitted. For example, if a homeowner contracts to have her house painted by a contractor outside the regular economy, the paint and other materials purchased will be included in the GDP; the value of labor will not. As a result, a method that determines the extent of income earned but not reported for tax purposes should determine the statistics discrepancy between personal income, estimated by the Bureau of Economic Analysis, and that estimated by the IRS.

This approach is not reliable since there are errors in both estimates of aggregate income. The main problems are: (1) the two agencies use substantially

[3]There are many definitions of an underground economy. In any case, all activities in an underground economy are subject to taxes and hence those, who fail to report their income, are evading taxes. See Tanzi (1982) for how to estimate the extent of the underground economy. According to Frey and Pommerehne (1982), common techniques can be grouped as: (1) using discrepencies between income and expenditures; (2) using tax auditing and other compliance methods; (3) information from labor market and (4) using monetary aggregate. Due to different definitions of the underground economy and techniques used, the estimates of underground economy vary widely; for example, in 1976 the estimates ranged from 5.9% of GDP to 21.7% estimated by the IRS using method (2) and Feige (1979) using method (4), respectively.

different definitions of income. Although there is an attempt to reconcile the two estimates, there are still errors. The largest known missing reconciliation item is income that is excluded from IRS data, such as income earned by low income individuals; (2) part of income is not captured by either the IRS or the BEA. Organized non-cash transactions, such as bartering and traditional crime activities like narcotics and prostitution, are not included at all by the two agencies. (3) the data compiled by the BEA is also subject to bias. The BEA estimate of income is based on information supplied by state employment agencies. Thus, BEA relies upon what employers report to the government, not on what employees report. If, however, an employer does not report wage and salary payments, this income will not be measured by the BEA. This suggests an under-estimate of the income by the BEA. (4) there are errors in IRS data.

The following table is estimated tax evasion using discrepencies between personal income estimated by the Bureau of Economic Anamysis (BEA) and income reported to the Internal Revenue Service (IRS) in $billion.

The second approach employs laboratory experiments to study an individual's compliance behavior in response to a set of tax instruments, such as tax rate, probability of detection and fine. Such studies include Friedland, Maital and Rutenberg (1978) and Becker, Buchner and Sleeking (1987). Friedland, Maital and Rutenberg (1978) employ a tax evasion game in which participants were given a monthly income and a set of tax and punishment parameters. Given these variables, they were requested to declare tax liability. The major findings of this study are that evasion increased with the tax rate and that evasion fell as the fine is increased.

Becker, Buchner and Sleeking (1987) conducted a similar experiment but with

Table 2.1: A Summary of Estimated Tax Evasion

Year	*BEA*	*IRS*	*gap*	% of gap
66	524.6	468.5	56.1	10.6
67	558.9	504.8	54.1	9.6
68	612.2	554.4	57.8	9.4
69	667.4	603.5	63.9	9.5
70	703.7	631.7	72	10.2
71	749.5	673.6	75.9	10.1
72	829.9	746	83.9	10.1
73	931.8	827.1	104.6	11.2
74	1009.3	905.5	103.8	10.2
75	1051.8	947.8	104	9.8
76	1172.4	1053.9	118.5	10.1
77	1300.6	1158.5	142.1	10.9
78	1473.1	1302.4	170.7	11.5
79	1662	1465.4	196.6	11.8
80	1832.1	1613.7	218.4	11.9
81	2021.8	1772.6	249.2	12.3
82	2099.4	1852.1	247.3	11.7
83	2234.8	1942.6	292.2	13
84	2488.5	2139.9	348.6	14
85	2651.7	2306	345.8	13.1
86	2878.9	2481.7	397.3	13.8
87	3156.5	2773.8	382.7	12.1
88	3430.7	3083	347.6	10.1
89	3666.4	3256.4	410	11.1
90	3821.3	3405.4	415.9	10.8
91	3873.8	3464.5	409.2	10.5
92	4116.7	3629.1	487.6	11.8
93	4277.5	3723.3	554.1	12.9
94	4513.1	3907.5	605.5	13.4
95	4819.7	4189.4	630.4	13

Sources: From Frank (1998).

an inclusion of endogenous transfers of tax revenue back to the taxpayers, and with income being earned by the participants. With respect to tax evasion, a high transfer, the probability of detection and the perceived level of income all had negative effects. Higher income raised the level of evasion. The audit level had a negative effect on tax evasion.

The third approach uses survey or interview data to estimate the extent of tax evasion and study people's compliance behavior to a set of tax instruments. The widely-used data sets are those of the IRS's Taxpayer Compliance Measurement Program, or TCMP. The IRS collects about 55,000 individual-level data every three years and stores them in TCMP data sets. The IRS conducts a program of intensive audits on a large stratified random sample of tax returns, using the results to develop a formula which is used to inform the selection of returns for regular audits. The TCMP data consists of line by line information about what the tax payer reported, and what the examiner concluded was correct. This data forms the basis for the IRS estimates of the aggregate "tax gap," and provides much useful information about the patterns of noncompliance with respect to such variables as income, occupation, line item, region of the country, age, and marital status. While informative, it is widely recognized that even the intensive TCMP audits imperfectly reveal particular kinds of non-compliance, such as income from the underground economy; this is partly because non-filers are not captured at all.

The following table is estimates of unreported income for 1976, by Type of Income in $billion.

Table 2.2: Estimates of Unreported Income

Type of Income	Lower Estimates: TCMP[a]	Other Sources	Nonfiling	Total	Higher Est.: Total
Legal Sector[f]:					
Self-Employed[c]	19.8	3.5	9.7	33	39.5
Wages and Salaries	3.5	5	12.8	21.3	26.8
Interest	1.4	1.8	2.2	5.4	9.4
Dividends	1.4		0.7	2.1	4.7
Rents and Royalties	2.6		0.6	3.2	5.9
Pensions, etc.	2.1		1.5	3.6	5.4
Capital gain[d]	2.9	1		3.9	5.1
Other[e]	1.7	0.6		2.3	2.9
TOTAL	35.4[b]	12	27.5	**74.9**	**99.7**

Sources: Kenadjian (1982).

a) Stands for Taxpayer Compliance Measurement Program.

b) Using TCMP, at least, will underestimate the unreported income by almost 50%.

c) Self-employment income covers net earnings of farm and non-farm proprietorships and partnerships as well as net earnings of self-employed individuals working outside the context of regularly established businesses in the legal sector.

d) Excluded from the National Income and Product Account (NIPA) income concept which defines income as earnings arising from the current production of goods and services.

e) Includes alimony, lottery winnings, prizes and awards and other types of income. Most of the incomes included here are excluded from NIPA since they represent transfer payments.

f) The IRS estimates illegal-source incomes to be between \$25.3 and \$35.2 billion; the numbers again are not reflected by the TCMP. Source IRS, "Estimates of Income Unreported on Individual Income Tax Returns" (1979).

Clotfelter (1983) uses 1969 TCMP data to investigate how non-compliance responded to changes in the environment. He employed a tobit model, explaining, for each of ten audit classes, noncompliance as a function of the combined federal and state marginal tax rate, after-tax auditor-adjusted income, and a set of demographic variables available on returns. One conclusion is that noncompliance is strongly positive related to the marginal tax rate, with the elasticity ranging from 0.5 to over 3.0.

Witte and Woodbury (1985) use econometric techniques and 1969 TCMP to study the effects of the probability of audit and non-compliance. They estimate a separate regression equation for each audit class. They find that voluntary compliance ranges from 71.1 to 98.5 percent. The mean compliance level was highest for low and medium income wage and salary workers and lowest for small proprietors. Also, the elasticity of voluntary compliance with respect to audit probability ranges from 0.02 for small proprietors to 0.002 for middle-income wage and salary workers.

Dubin and Wilde (1988), using cross-section data of 1969 TCMP and an econometric analysis, indicate that an increase in the audit rate can induce greatere tax compliance. Also, they found that the audit rate is endogenous, conditional on compliance level and income class.

Dubin, Wilde, and Graetz (1990) make use of state-level time series cross-section data from 1977 through 1986 to investigate the impact of audit rates and tax rates on tax compliance. They do not, however, have a direct measure of noncompliance, but instead use tax collection per return filed per capita as measures of non-compliance. They conclude that the continual decline in the audit rate over this period caused a significant decline in IRS collection – amounting to $41 billion by 1985.

Feinstein (1991) performs a pooled cross-section analysis of 1982 and 1985 TCMP data, thus mitigating the problem that in a single cross-section (other than for cross state differences) the marginal tax rate is a function of income, making it difficult to separately identify tax and income effects. Feinstein's analysis suggests a negative impact of the marginal tax rate on evasion, contradicting Clotfelter (1983)'s results.

Beron, Tauchen and Witte (1992) employ TCMP data aggregated by the IRS to the three digit zip code level. In an attempt to deal with the potential endogeneity of the intensity of enforcement, they model the simultaneous determination of tax reporting and the odds of an audit for each of several audit classes in each zip code area. Their instrument for this is the level of IRS resources relative to the number of returns. Of course, this may vary if the IRS targets its resources toward areas believed to be particularly noncompliant, thus invalidating its use as an instrument. Beron, Tauchen, and Witte argue that because the IRS has not been able to distribute its resources among districts so as to achieve its goals, it is a valid instrument. They find that increasing the odds of an audit significantly increases reported AGI and tax liability for low- and high-income (more than $50,000 per annual) groups, but not for all groups.

Fortin and Lacroix (1994) use a random survey of 2,134 adult individuals in Quebec City in 1985 to estimate various elasticities of labor supply in regular and irregular sectors. They suggest that a rise in the probability of detection and in penalties would increase labor supply in the regular sector while reducing labor supply in the irregular sector. A rise in wages in the regular sector would increase labor supply in the regular sector while reducing labor supply in the irregular sector. Likewise, a rise in wages in the irregular would increase the labor supply in these irregular while reducing labor supply in the regular sector.

2.3 Empirical Results and Data Concerns of Evasion and Non-compliance

"Regression analysis of tax evasion is straightforward except for two problems: you can't measure the left-hand side variable, and you can't measure the right hand side variables!" Remarks Harvey Galper in Slemrod and Yitzhaki (1997)

Tax evasion is notoriously difficult to measure. Obviously, it is reasonable to be skeptical of attempts to measure activities whose purpose is to avoid detection. People have an incentive to hide information about evasive behavior and this concealment makes empirical work quite difficult.

Data from surveys or interviewing are unrealiable. These surveys are subject to a number of methodological problems such as nonresponse, evasiveness, and misrepresentation, and their numbers are highly suspect. For example, individuals may not remember their reporting decisions, they may not respond at all if they feel threatened by the sensitive nature of the questions, or they may not respond truthfully. As Slemrod and Yitzhaki (1997) warn "merely asking just won't do."

Another data problem arises from the ambiguity of definitions of evasion and noncompliance and the illusive nature of the data. As discussed in Chapter One, it is never clear in practice when tax evasion and non-compliance really take place. The subjective values of probability of detection and penalty, especially from the point of view of tax payers, are controversial and vary widely.

It is widely recognized that even intensive TCMP audits, while informative, imperfectly reveal particular kinds of non-compliance, such as income from the underground economy; non-filers are not captured at all by TCMP.

Empirical Results

1) The effect of tax rate on evasion is ambiguous. Clotfelter (1983), using the

1969 TCMP, suggests that a higher tax rate induces more tax evasion; Feinstein (1991) performs a pooled cross-section analysis of 1982 and 1985 TCMP data, suggests a negative impact of the marginal tax rate on evasion, contradicting Clotfelter (1983)'s results.

2) The propensity to evade is reduced by an increased probability of detection. This result is supported by Witte and Woodbury (1985) using TCMP and econometric analysis and Friedland, Maital and Rutenberg (1978) and Becker, Buchner and Sleeking (1987) using experiments.

3) The propensity to evade is reduced by an increase in penalty. This result is supported by Friedland, Maital and Rutenberg (1978) using laboratory experiment.

4) The only study on the relationship between audits and penalties and labor supply is Lacroix and Fortin (1992). Using a random survey, they suggest that a rise in penalties and probability of detection would reduce the labor supply in the irregular sector while increasing labor supply in the regular one.

5) The relationship between income level and evasion is ambiguous. Spicer and Lundstedt (1976) employing interviewing survey and econometric analysis, reveal that an increase in income reduces evasion. In contrast, Becker, Buchner and Sleeking (1987), using laboratory experiments, suggest that income level has a positive effect on evasion.

In the next chapter we first provide a literature review on marginal cost of funds with tax evasion and then construct a model for the marginal cost of funds with tax evasion.

Chapter 3

A MODEL FOR MARGINAL COST OF FUNDS WITH TAX EVASION

In this chapter we first review the existing literature on the marginal cost of funds with tax evasion. In the second section, we derive a simple model of the marginal cost of funds. The model may be called "marginal cost of funds with tax evasion and costly administration."

3.1 Introduction and Literature Review

The literature on the marginal cost of funds has appeared in economic journals; examples include Browing (1976) and Stuart (1984). However, only recently has the issue been studied along with tax administration and evasion. The few studies are Mayshar (1991a), Fortin and Lacroix (1994) and Slemrod and Yitzaki (1996).

Mayshar (1991a) proposes a measurement of the marginal cost of public funds and a criterion for optimal administration in which tax evasion exists and administration is costly. The author uses and applies a simple model with one good and one tax to measure the MCF of the U.S. economy. Mayshar argues that the distortion from costs of administration, tax evasion and the compliance costs of tax players are even larger than the conventional distortion, the distortion from

labor substitution.

Fortin and Lacroix (1994) extend the concept of the MCF to incorporate tax evasion in the labor market. Taking a slightly different approach from Mayshar (1991a), the authors treat the evasion characteristics explicitly by separating the labor market into regular and irregular sectors. Applying their model to the province of Quebec, Canada, they compute MCFs with respect to the labor tax rate and also the share of the irregular sector to the MCFs. Then they use simulations to measure the impact of various tax reforms.

Fortin and Lacroix argue that evasion could induce certain costs to the society in the following ways. First, evasion is a source of uncertainty for tax evaders. Second, it may incur real costs for evaders who spend time and money trying to conceal their income. Third, it would create a social stigma or psychic costs to evaders. Fourth, it would incur costs to related authorities; the IRS would be required to spend resources for enforcement.

Slemrod and Yitzhaki (1996) argue that the concept of the marginal efficiency cost of funds[1] is an appropriate direction to evaluate tax reforms. They discuss the merits, applicability, and limitations of the concept.

3.2 A Model for the Marginal Cost of Funds with Tax Evasion

The model is a modification of Allingham and Sandmo (1972). I enhance Allingham and Sandmo's model by adding leisure to the utility function[2]. Basically,

[1] According to Slemrod and Yitzhaki (1996), the concept is slightly different from the MCF since efficiency considerations are separated from distributional issues.

[2] According to Ballard and Fullerton (1992), our paper follows the Stiglitz -Dasgupta - Atkinson -Stern approach which allows MCFs to be smaller than one. In contrast, the Pigou-Harberger -Brownig approach ensures that MCF is greater than one since only compensated labor demand is recognized and there is no income efffect.

tax evasion with labor supply can be viewed as an individual's optimal decision given the following set of parameters (1) income tax rate, (2) probability of detection, (3) fine or penalty rate, (4) wage and (5) lump-sum tax. Given this set of parameters, the individual tries to maximize his expected utility by choosing two decision variables: his labor supply and reporting taxable income. The amount of declared taxable income can be considered to be a demand for risky assets, with a high return if the unreported goes undetected and a low return when the unreported is detected by the authorities.

The problem can be restated in more detail as follows. The economy consists of a large number of households on a unit interval of one, one firm and a benevolent government. There is one commodity produced by the firm using linear technology. Labor is the only input for the economy.

Household.

An average household is endowed with one unit of time and trades labor for wages from the firm. The individual has to pay taxes unwillingly. However, it is possible for the indiidual to avoid some of the tax burden by underreporting her taxable income to authorities. If she chooses to do so, she faces the probability of an audit and fine. The audits are costly and reveal true information accurately. The probability of an audit depends on the level of auditing expenditures. The greater the expenditures, the higher the probability of an audit will be.

If an individual underreports income from an industry, there are two possibilities, CAUGHT or NOT caught. If caught, the individual has to pay a fine. To be specific, the probability to getting caught evaded is p, and hence the probability of NOT getting caught is $(1-p)$.

The individual has the von Neumann-Morgernstern utility function:

$$\Phi = (1-p)u(c^1, 1-L) + pu(c^2, 1-L) + v(g) \tag{1}$$

$\Phi(.)$ is assumed to be twice continuously differentiable, strictly concave, decreasing in L and increasing in c and g. In addition to strict concavity, assume that the individual is risk averse with respect to consumption, which implies that $u_{cc} < 0$. The level of public good, g, is exogenously given and financed by taxes and fines. Given the separability of the sub-utility function v(g), g does not affect individual labor supply or the level of tax evasion.

There are two states of the economy, one in which evaders are caught and one in which evaders are NOT caught. The individual's budget constraint, which must hold for every state, is given as follows:

$$c^1 = -T + wL(1-t) + xt \tag{2}$$

$$c^2 = -T + wL(1-t) + xt - fx \tag{3}$$

where

c^1= consumption if the individual does not get caught

c^2= consumption if the individual get caught

L = labor supply

x = undeclared income (or evaded income) so $0 \leq x \leq wL$.

w = wage rate

g = neutral public good financed by taxes and fine

p = probability of an audit

e = e(t, p, f) administrative expenditure function which is a function of tax rate, probability of auditing and fine rate.

f = fine rate

t = labor income tax

T = lump-sum tax

fx = a specific fine function, which is a function of fine rate and the individual evaded income [3].

Formally, the individual's optimization problem can be stated as the following.

Max

$$(1-p)u(c^1, 1-L) + pu(c^2, 1-L) + v(g) \tag{4}$$

subject to

$$c^1 = -T + wL(1-t) + tx \tag{5}$$

$$c^2 = -T + wL(1-t) + tx - fx \tag{6}$$

The Lagrangian and the first order conditions of the maximization problem are the following

$$\varsigma = (1-p)u(c^1, 1-L) + pu(c^2, 1-L) + \lambda^1(-T + wL(1-t) + tx - c^1)$$

$$+\lambda^2(-T + wL(1-t) + tx - fx - c^2) \tag{7}$$

$$\frac{d\varsigma}{dc^1} : (1-p)u_c(c^1, 1-L) = \lambda^1 \tag{8}$$

$$\frac{d\varsigma}{dc^2} : pu_c(c^2, 1-L) = \lambda^2 \tag{9}$$

$$\frac{d\varsigma}{dL} : (1-p)u_L(c^1, 1-L) + pu_L(c^2, 1-L) - \lambda^1 w(1-t) - \lambda^2 w(1-t) = 0 \tag{10}$$

$$\frac{d\varsigma}{dx} : \lambda^1 t + \lambda^2(t-f) = 0 \text{ or } \lambda^1 = \lambda^2(\frac{f}{t} - 1) \text{ and } \lambda^1 + \lambda^2 = \lambda^2\frac{f}{t} \tag{11}$$

From (10), $(1-p)u_L(c^1, 1-L) + pu_L(c^2, 1-L) = (\lambda^1 + \lambda^2)w(1-t)$. This standard result simply means that, at the optimum, the marginal disutility of

[3]For simplicity, we assume the functional form for the fine function. According to Balassone and Jones (1998), $\frac{dx}{dt}$ could be either greater or smaller than zero depending on penalty structure. This paper employs the structure, fx, so that even with a decreasing absolute risk aversion (DARA) utility, $\frac{dx}{dt}$ could be greater than zero. The positive result is desired here, since it is consistent with the intuition that a higher tax rate will encourage more tax evasion.

labor is equal to the marginal expected utility of income from a marginal change in the labor supply.

Equation (11) demonstrates that the optimal level of evasion is reached when the expected gain from evasion equals the expected loss.

To ensure an interior solution, we need the two following conditions. First, from (11) the condition is $f > t$, so that we have positive sign of marginal utility of consumption of both states, or $\lambda^1$and $\lambda^2 > 0$.

Given the concavity of the utility function, the second condition ensures that the expected payoff from evasion is strictly positive, or (1-p)tx + px(t-f)>0[4]; hence, $pf < t$. Combining condition one and two, we have $f > t > pf$ or $\frac{t}{p} > f > t$.

From the First Order Conditions, we can now derive demand functions for $c^{1*}(w, t, f, p, T)$ and $c^{2*}(w, t, f, p, T)$ *and* the labor supply function $L^*(w, t, f, p, T)$. Substituting $c^{1*}(w, t, f, p, T)$, $c^{2*}(w, t, f, p, T)$ *and* $L^*(w, t, f, p, T)$ into the expected utility gives the indirect utility function $V(w, t, f, p, T) + v(g)$.

The partial derivatives of the indirect utility functions are:

$$V_t(w, t, f, p, T) = -(wL - x)[\lambda^1 + \lambda^2] \tag{12}$$

$$V_f(w, t, f, p, T) = -\lambda^2 x \tag{13}$$

$$V_p(w, t, f, p, T) = -u(c^1, 1 - L) + u(c^2, 1 - L) \tag{14}$$

$$V_T(w, t, f, p, T) = -\lambda^1 - \lambda^2 \tag{15}$$

We can write $V(w, t, f, p, T) = E(U^*) = (1 - p)u(c^{1*}, 1 - L^*) + pu(c^{2*}, 1 - L^*)$

[4]For a linear utilty function, the expected pay off is greater or equal to zero, and for a concave utility function or risk averse preference, the expected pay off, to compensate for risk taking, is strictly positive.

and after partial differentiating with respect to T

$$-V_T(w,t,f,p,T) = E(u_c) = (1-p)u_{c^1} + pu_{c^2} = \lambda^1 + \lambda^2 \tag{16}$$

Using (11),

$$-V_T(w,t,f,p,T) = E(u_c) = \frac{f}{t}\lambda^2 \tag{17}$$

Using equations (11), (16) and (17), we have

$$\frac{V_t}{V_T} = wL - x \tag{18}$$

$$\frac{V_f}{V_T} = \frac{tx}{f} \tag{19}$$

$$\frac{V_p}{V_T} = \frac{u(c^{1*}, 1-L^*) - u(c^{2*}, 1-L^*)}{E(u_c)} \tag{20}$$

Public Sector

The government needs to maximize social welfare function, $W[V, v(g)]$[5], or in this case, an average household utility function subject to a budget constraint. The government employs a combination of tax instruments (t, f, p, T) to raise funds. The revenues after administrative costs, $e(t,p,f)$, will be used to provide the public good, $g(w,t,f,p,T)$. The government's budget constraint is:

$$R(w,t,f,p,T;g) = T + (wL - x)t + pfx^6 - e(t,p,t) \tag{21}$$

and the revenues after administrative expenses will be used to provide public good

$$g = R(w,t,f,p,T)$$

Formally, the government's problem can be written as:

[5] $V(w,t,f,p,T) = E(U^*) = (1-p)U(c^{1*}, 1-L^*) + pU(c^{2*}, 1-L^*)$

[6] By using the Law of Large Number, a fraction p of the entire population got caught. As a result, the expected fine revenue will be pfx.

Max

$$W(w,t,f,p,T,g) = (1-p)u(c^{1*}, 1-L^*) + pu(c^{2*}, 1-L^*) + v(g) \tag{22}$$

Replacing g with R, the first order conditions of the government problem are the following:

$$W_t : V_t + v_g[R_t] = 0 \tag{23}$$

$$W_f : V_f + v_g[R_f] = 0 \tag{24}$$

$$W_p : V_p + v_g[R_p] = 0 \tag{25}$$

$$W_T : V_T + v_g[R_T] = 0 \tag{26}$$

It is natural that v_g is positive; hence, the first order conditions require that (R_t, R_f, R_p, R_T) are all positive.

We can rearrange equation (23) to (26) in terms of MCFs and MBFs, $\frac{v_g}{-V_T}$,as the following:

$$\frac{V_t}{R_t V_T} = \frac{V_f}{R_f V_T} = \frac{V_p}{R_p V_T} = -\frac{v_g}{R_T V_T} \tag{27}$$

Equation (27) indicates that at the optimum, all MCFs and MBFs are equal.

In a special case when the lump-sum tax is non-distortionary and thus $R_T = 1$, we get

$$\frac{V_T}{R_T V_T} = \frac{-v_g}{R_T V_T} = 1, \text{or } V_T = -v_g \tag{28}$$

That is the marginal utility of the public good is equal to the marginal disutility of the lump-sum tax.

The government net revenues and marginal revenues of each tax instrument are:

$$R = T + (wL - x)t + pfx - e(t,p,t) \tag{29}$$

$$R_t = wL - x - e_t(t,p,f) + wt\frac{\partial L}{\partial t} + [pf - t]\frac{\partial x}{\partial t} \tag{30}$$

$$R_f = px - e_f(t,p,f) + wt\frac{\partial L}{\partial f} + [pf - t]\frac{\partial x}{\partial f} \tag{31}$$

$$R_p = fx - e_p(t,p,f) + wt\frac{\partial L}{\partial p} + [pf - t]\frac{\partial x}{\partial p} \tag{32}$$

Where R_t is the derivative of R with respect to t and so on.

According to equation (29), the total revenue after administration costs or net revenue consists of the lump-sum tax, income tax and fine revenues. Equation (30) shows that the marginal revenue is composed of the direct effect of tax rate, $wL - x - e_t(t,p,f)$, the indirect effect of tax rate on working and reporting behaviors $wt\frac{\partial L}{\partial t}$ and $[pf - t]\frac{\partial x}{\partial t}$, respectively. According to equation (31), the effect of an increase in fine rate is analogously similar to the effect of tax rate, and so on.

3.3 Marginal Cost of Funds Models

Following Mayshar (1991a), the marginal cost of funds of tax instrument i is

$$MCF_i = -\frac{\frac{\partial EV}{\partial i}}{\frac{\partial V}{\partial I}} / \frac{\partial R}{\partial i} \tag{33}$$

where $\frac{\partial EV}{\partial i}$ is the welfare cost of tax instrument i. V is indirect utility, $\frac{\partial V}{\partial I}$ is the marginal utility of income ($-V_T$ in this paper), and $\frac{\partial R}{\partial i}$ is the derivative of R with respect to tax instrument i. That is, the numerator is the welfare cost of tax instrument in term of income, while the denominator is the marginal revenue.

Now, we derive the marginal cost of funds for each tax instrument. First, using equation (18) and (30), the marginal cost of funds of income tax is:

$$MCF_t = \frac{wL - x}{wL - x - e_t(t,p,f) + wt\frac{\partial L}{\partial t} + [pf - t]\frac{\partial x}{\partial t}} \tag{34}$$

Similarly, using equations (19) and (31), the marginal cost of funds of the fine rate is:

$$MCF_f = \frac{\frac{tx}{f}}{px - e_f(t, p, f) + wt\frac{\partial L}{\partial f} + [pf - t]\frac{\partial x}{\partial f}} \tag{35}$$

Using equations (20) and (32), the marginal cost of funds of the probability of detection is:

$$MCF_p = \frac{\frac{u(c^{1*}, 1-L^*) - u(c^{2*}, 1-L^*)}{E(u_c)}}{fx - e_p(p) + wt\frac{\partial L}{\partial p} + [pf - t]\frac{\partial x}{\partial p}} \tag{36}$$

We can determine that the marginal cost of funds of the lump-sum tax is:

$$MCF_T = \frac{1}{1 + wt\frac{\partial L}{\partial T} + [pf - t]\frac{\partial x}{\partial T}} \tag{37}$$

It is clear that the cost is equal to one if there is no income effect. Further, the cost is always less than one if leisure is normal and DARA is assumed.

Considering model (34), it is not clear how allowing for evasion would change the MCF of the tax rate. This is because the elasticity of evasion with respect to tax rate is indeterminate both theoretically and empirically. Hence, the contribution of evasion to the MCF of tax rate is indeterminate. For example, if a rise in tax rate encourages people to evade more, then the MCF will be greater than the one that does not allow tax evasion[7]. However, if people report more when the tax is higher, then the MCF will be smaller. For the administrative cost, it always makes the MCFs greater as expected. The next chapter will provide further discussion on how the evasion effects the MCF.

The models (35) and (36) are our contribution to the literature.

[7]This is because the negative term [pf-t] $\frac{\partial x}{\partial t}$ makes the denominator smaller and hence makes the MCF greater.

3.4 Total Marginal Cost of Funds (TMCF)

It is easy to put models (34) to (37) together in a meaningful way. Multiply $MCFi$ in equation (33) with di and Ri, and then sum up all i. Dividing by dR results in the following:

$$TMCF = \frac{\Sigma_i(MCF_i R_i di)}{dR} = \Sigma_i(\beta_i MCF_i di) \tag{38}$$

where di is the change in tax instrument i, Ri is the change in revenue from a change in tax instrument i, dR is the total change in tax revenue from the change from all tax instruments, and β_i is the revenue share of tax instrument i. If there is no tax evasion and hence no MCF of p and f, the TMCF is equal to MCF of tax rate.

The TMCF is an index that summarizes all models of tax instruments. It is just a summary of the cost of tax funds when the government employs all tax instruments simultaneously. Instead of employing many MCFs for differnt tax instruments, we can use the TMCF, a single index, to estimate the cost of funds for a certain society and to compare the costs across economies.

In this chapter we explicitly derive and provide models for marginal cost of funds of tax rate, fine rate and probability of detection and lump-sum in equations (34) to (37), respectively. As disussed previously, it is not clear how adding evasion would affect the traditional MCF of the tax rate. This is because the elasticity of evasion with respect to the tax rate is indeterminate in sign. Empirical studies also confirm the inconclusive sign. In the next chapter, we analyze the models in more detail.

Chapter 4

AN ANALYSIS OF THE MCF MODELS

This chapter analyzes and discusses the basic properties of the MCF models derived in the previous chapter. Mainly, we try to answer the question how changes in tax parameters could affect the Marginal Cost of Funds. It will be shown that the effect of the parameter changes on the cost depends on assumptions of utility function.

In the first section, we provide a comparative statics analysis of labor supply and evaded income. The study analyzes and derives the changes in labor supply and evaded income which result from variations in tax parameters within a setting of uncertainty. The analysis will pave a way to an understanding of the basic properties of the MCF models and the conditions under which MCFs will be greater or less than one. In the second section, we discuss why MCFs can be greater or smaller than one and then analyze the conditions under which the MCFs will be greater or less than one. Finally, numerical simulations are performed. Due to the complexity of the problem, numerical simulations are employed to study the basic properties of MCF models. We first use simulations to estimate MCFs and then to study changes in MCFs which result from variations in tax rate, fine rate and probability of detection.

4.1 Comparative Statics Analysis of Labor Supply and Evaded Income

The aim of this comparative statics analysis is to investigate the changes in labor supply and evaded income which result from variations of tax parameters[1]. This analysis will allow us to analyze basic properties of MCF models and conditions under which MCFs will be greater or less than one. The setting is similar to that of the previous chapter.

Let's reconsider equation (4). We assume that $u' > 0$, $u'' < 0$, $y' < 0$, $y'' < 0$ and the utility exhibits Decreasing Absolute Risk Aversion (DARA), unless state otherwise, or $-\frac{u''(c^2)}{u'(c^2)} > -\frac{u''(c^1)}{u'(c^1)}$ where $c^1 > c^2$. Assuming further separability of utility function between consumption and leisure and using equation (5) and (6), we get:

$$(1-p)u(-T+wL(1-t)+tx)+pu(-T+wL(1-t)+tx-fx)+y(L)+v(g) \quad (39)$$

Maximize the new expected utility function by differentiating (39) with respect to L and x :

$$(1-p)u'(c^1)w(1-t)+pu'(c^2)w(1-t)+y'(L)=0 \quad (40)$$

$$(1-p)u'(c^1)t+pu'(c^2)(t-f)=0 \quad (41)$$

Total differentiation of FOCs (40) and (41) gives the following four results

[1] A comparable but less extensive analysis of tax evasion and labor supply can be found in Anderson (1977). However, this thesis puts more attention on attitudes toward risk and thus analyses the aspect more extensively. Most, but not all, of the comparative statics results in Anderson (1977) are consistent with those in this study.

RESULT 1: A rise in lump-sum tax will always increase labor supply. A rise in lump-sum tax will reduce tax evasion with DARA while increase tax evasion with IARA. With CARA it will be neutralized.

From the total differentiation, we have

$$\frac{dL}{dT} = \{p(1-p)u''(c^1)u''(c^2)w(1-t)f^2\}/D \tag{42}$$

$$\frac{dx}{dT} = y''(L)E/D \tag{43}$$

where

$$D = p(1-p)u''(c^1)u''(c^2)w^2(1-t)^2f^2 + y''(L)[(1-p)u''(c^1)t^2 + pu''(c^2)(f-t)^2] > 0$$

$$E = (1-p)u''(c^1)t - pu''(c^2)(f-t) > 0$$

With DARA and FOC (41), $E > 0$ [2].

From (42), it is clear that a decrease in income will reduce leisure or induce a greater supply of labor. In other words, with higher a lump-sum tax that reduces income, the individual will work more. This is consistent with the assumption that leisure is normal.

From (43), we can see that the income effect of evaded income is strictly negative. That is, a higher lump-sum tax that causes lower income will discourage evasion. In other words, the richer an individual becomes, the more that individual evades. This result arises from the DARA assumption. However, the income effect will be neutralized with CARA while it will increase tax evasion with IARA.

RESULT 2: The substitution effect of a rise in tax rate on the labor supply is always negative while the effect on evaded income is indeterminate with DARA.

[2] $E = 0$ with CARA and $E < 0$ with IARA.

Accordingly, the total effect, income plus substitution effects, of a rise in tax rate on labor supply is always indeterminate and the effect on evaded income is indeterminate with DARA. With IARA and CARA, the substitution effect on evaded income is positive and thus the total effect is positive.

From the total differentiation, we get

$$D * \frac{dL}{dt} = (wL - x)\frac{dL}{dT} + \{[(1-p)u'(c^1)wt + pu'(c^2)w(t-f)(1-f)] * \\ [(1-p)u''(c^1) + pu''(c^2)]\} \tag{44}$$

$$D * \frac{dx}{dt} = (wL - x)\frac{dx}{dT} - y''(L)[(1-p)u'(c^1) + pu'(c^2)] \\ +\{[(1-p)u'(c^1) + pu'(c^2)] * w^2(1-t) * [-(1-p)u''(c^1) + pu''(c^2)(f-1)]\} \tag{45}$$

From (44), with DARA the income term $(wL - x)\frac{dL}{dT}$ has the same sign as $\frac{dL}{dT}$ and thus is positive, while the substitution term, $(\frac{dL}{dt})_{compensated} = \{[(1-p)u'(c^1)wt + pu'(c^2)w(t-f)(1-f)] * [(1-p)u''(c^1) + pu''(c^2)]\}$, is strictly negative. As a result, the total effect of tax rate on labor supply is indeterminate. The indeterminate outcome is similar to that of standard studies of labor supply and tax rate, such as in Hausman (1985 ch4). As Hausman (1985 ch4) argues, it is the job of numerical analysis to determine the size and sign of the sum of income and substitution effects of tax on labor supply.

From (45) with DARA the income term, $(wL - x)\frac{dx}{dT}$, is negative while the substitution term, $(\frac{dx}{dt})_{compensated} = \{[(1-p)u'(c^1) + pu'(c^2)] * w^2(1-t) * [-(1-p)u''(c^1) + pu''(c^2)(f-1)]\} - y''(L)[(1-p)u'(c^1) + pu'(c^2)]$, is indeterminate; thus, the total effect of tax rate on evaded income is indeterminate[3].

[3]However, with IARA, the income and substitution terms of evaded income are strictly positive. With CARA, the income term is zero and the substituion term is positive. In sum, with IARA or CARA the total effect will be strictly positive. This result is consistent with those of Balassone and Jones (1998) although there is no labor supply in their model.

RESULT 3: With DARA. the substitution effects of a rise in fine rate on the labor supply and evaded income are negative. The total effect of a rise in fine rate on labor supply is indeterminate, while the total effect on evaded income is negative. With CARA and IARA, the substitution effects on labor supply is positive and is negative on evaded income, and thus the total effects are positive for labor supply and indeterminate for evaded income.

From the total differentiation, we get

$$D * \frac{dL}{df} = \frac{tx}{f}\frac{dL}{dT} - pu'(c^2)w(1-t)E \tag{46}$$

$$\begin{aligned} D * \frac{dx}{df} = \frac{tx}{f}\frac{dx}{dT} - \frac{y''(L)}{f}[(1-p)u''(c^1)t^2x + pu''(c^2)(f-t)^2] \\ +\{pu'(c^1)w^2(1-t)^2 * [(1-p)u''(c^1) + pu''(c^2)]\} \end{aligned} \tag{47}$$

From (46), with DARA the income term $\frac{tx}{f}\frac{dL}{dT}$ is positive while the substitution term $(\frac{dL}{df})_{compensated} = -pu'(c^2)w(1-t)E$, is negative: thus, the total effect of fine rate on labor supply is indeterminate. Intuitively. we would expect that the substitution term of labor will be negativebecause the fine will reduce the expected return on labor supply after tax and fines, discouraging people to work.

From (47) with DARA, the income term $\frac{tx}{f}\frac{dx}{dT}$. is negative and the substitution term $(\frac{dx}{df})_{compensated} = \{pu'(c^1)w^2(1-t)^2 * [(1-p)u''(c^1) + pu''(c^2)]\} - \frac{y''(L)}{f}[(1-p)u''(c^1)t^2x + pu''(c^2)(f-t)^2]$ is also negative and thus the total effect of fine rate on evaded income is negative, as expected.

RESULT 4: With DARA, the total effect of probability of detection on the labor supply is indeterminate while the total effect on evaded income is strictly negative. With IARA and CARA, the total effects on labor supply and evaded income are negative.

From the total differentiation, we have

$$D * \frac{dL}{dp} = -wf(1-t)\{(1-p)u''(c^1)tu'(c^2) - pu''(c^2)(f-t)u'(c^1) \tag{48}$$

$$D * \frac{dx}{dp} = w^2 f(1-t)^2[(1-p)u''(c^1)u'(c^2) + pu''(c^2)(f-t)u'(c^1)]$$

$$+y''(L)[u'(c^1)t + u'(c^2)(f-t)] \tag{49}$$

From (48) with DARA, the total effect of probability of detection on labor supply is indeterminate. However, with the Increasing Absolute Risk Aversion (IARA) or Constant Absolute Risk Aversion (CARA) assumption, the total effect would be negative.

From (49) the total effect of probability of detection on evaded income is always negative as expected.

The following tables 4.1, 4.2, 4.3 and 4.4 are summaries of the total effects and substitution effects of parameter changes, respectively.

Table 4.1 summarizes the total effects of parameter changes with DARA assumption.

Table 4.2 summarizes the total effects of parameter changes with IARA and CARA assumption.

Table 4.3. summarizes the substitution effects of parameter changes with DARA and IARA assumption.

Table 4.4. summarizes the substitution effects of parameter changes with CARA assumption.

Where ?, + and − denote indeterminate, positive and negative relationships between corresponding variables and parameters. * indicates zero with CARA or neutrality of income effect on evaded income with CARA.

Table 4.1: Total Effects with DARA

	parameters			
variables	t	f	p	T
L	?	?	?	$+$
x	?	$-$	$-$	$-$

Table 4.2: Total effects with IARA and CARA

	parameters			
variables	t	f	p	T
L	?	$+$	?	$+$
x	$+$	?	$-$	$+^{*}$

Table 4.3: Substitution Effects with DARA and IARA

	parameters	
variables	t	f
L	$-$	$-$
x	?	$-$

Table 4.4: Substitution Effects with CARA

	parameters	
variables	t	f
L	$-$	$+$
x	$+$	$-$

4.2 MCFs Can Be Greater Or Less Than One

According to Ballard and Fullerton (1992), one frequent misconception about the marginal cost of funds is that the cost must be greater than one. The authors show diagrammatically and numerically that the MCF of labor income tax is less than one if the labor supply curve is backward-bending or if the uncompensated labor supply elasticity is negative. In other words for any labor supply function, assuming leisure is normal if its income effect is great enough to surpass its substitution effect, then greater wage tax will induce labor to work more resulting in even higher tax revenues. The combination of direct tax and indirect induced tax revenues, if it exceeds the loss in utility from higher tax, makes the MCF less than one.

The logic is that given the society is not at her optimum, there exists distortionary tax and thus there is a room to reduce these distortions. Accordingly, if a public policy, such as a rise in wage tax, can increase any taxed activity resulting in more tax revenues, it will alleviate pre-existing tax distortions. For example, government provision of highway encourages the private purchase of taxable gasoline. In this case, the provision will increase the gasoline tax revenues, and thus reduce the marginal cost of funds for any tax used to finance the highway.

This argument is substantiated by papers that address cases in which MCFs are less that one. The papers are Fullerton and Handerson (1989) which addresses investment tax credit, Ballard and Medela (1991) which addresses externality-correcting pollution tax and Batina (1990) on interest income tax.

A more recent paper that provides a condition where the MCF is less than one is Dahlby (1998). In this study, the author explicitly describes the condition under which the MCF of the progressive income tax is greater or less than one.

The following section will discuss the conditions under which MCFs are greater or less than one.

4.3 Condition Under Which MCFs Are Greater or Less Than One

By decostructing the model into income and substitution terms, we can discuss the condition under which MCFs is greater or less than one. In this section, DARA is assumed, unless otherwise noted. From (34), MCF of income tax rate is greater than one iff

$$-wt(\frac{\partial L}{\partial t})_{compensated} - (pf-t)(\frac{\partial x}{\partial t})_{comp} >$$

$$(wL-x)wt(\frac{\partial L}{\partial T}) + (wL-x)(pf-t)\frac{\partial x}{\partial T} \tag{50}$$

That is, the sum of compensated or substitution terms is greater than the sum of income terms. In general, it is indeterminate whether the MCF is greater or less than one. This is because, even without evasion, either the income or substitution effect could be greater. As Hausman (1985) argues, it is the job of numerical analysis to determine the size and sign of the sum of income and substitution effects of tax on labor supply. However, it is clear here that the MCF of the tax rate is greater than one if there is no income effect. If there is no income effect, then the right hand side terms are all zero while the left hand terms are positive.

From (35), MCF of fine rate is greater than one iff

$$\frac{tx}{f} - wt(\frac{\partial L}{\partial f})_{comp} >$$

$$px + \frac{tx}{f}wt\frac{\partial L}{\partial T} + \frac{tx}{f}(pf-t)(\frac{\partial x}{\partial T}) + (pf-t)(\frac{\partial x}{\partial f})_{comp} \tag{51}$$

The left hand side consists of two adverse distortionary terms: the direct evasion cost of fine revenues and labor distortion. On the right hand side, we have four positive terms: direct fine revenues, income effects on labor, and income and substitution effects of evasion.

From (36), the MCF of probability of detection is greater than one iff

$$\frac{u(c^{1*}, 1 - L^*) - u(c^{2*}, 1 - L^*)}{E(u_c)} >$$

$$fx - e_p(p) + wt\frac{\partial L}{\partial p} + (pf - t)(\frac{\partial x}{\partial p}) \tag{52}$$

Due to the complexity of the problem, income and substitution effects of probability of detection will not be treated separatedly. The left-hand side consists of one adverse term: direct cost of probability of detection. On the right-hand side, we have three positive terms: direct fine revenues after administrative costs, indirect effects on labor supply and evasion.

From (37), MCF of lump-sum tax is greater than one iff

$$wt\frac{\partial L}{\partial T} + [pf - t]\frac{\partial x}{\partial T} < 0 \tag{53}$$

As discussed, we can deermine that with DARA, the MCF of lump-sum tax is always less than one; when there is no substitution, the income effect will induce people to work more and evade less.

In sum, we conclude that it is indeterminate whether MCFs of tax rate, fine rate and probability of detection are greater or less than one. This is because there are both income and substitution effects which normally have different signs and cannot be compared algebraically. Under certain assumptions, only the MCF of lump-sum tax is always less than one. Also, when the income effect is ignored, the MCF of tax rate cannot be less than one.

4.4 Numerical Simulations

This section aims to increase the understanding of the basic properties of MCF models by using numerical simulations. Due to the complexity of the problem and the results from section one, we cannot algebraically analyze the changes in MCFs which result from variations in tax parameters[4]. This leads to the use of numerical simulations for analysis of the MCF models. We first estimate MCF of each tax instrument and then the changes in MCFs which result from variations in tax rate, fine rate and probability of detection.

We employ a specific Cobb-Douglas utility function:

$$U = \alpha(1-p)\log(c^1) + \alpha p \log(c^2) + (1-\alpha)\log(1-L) \tag{54}$$

$$c^1 = -T + wL(1-t) + xt \tag{55}$$

$$c^2 = -T + wL(1-t) + xt - fx \tag{56}$$

where α and $(1-\alpha)$ are the shares of consumption and labor. respectively.

We use the following values to construct our benchmark

α	w	t	f	p	T
0.8	1	0.4	2	0.1	0.01

[4] $\frac{\partial}{\partial t} MCF_t = \frac{\partial}{\partial t}(\frac{wL-x}{R_t}) = \frac{R_t(w\frac{\partial L}{\partial t} - \frac{\partial x}{\partial t}) - (wL-x)\frac{\partial R_t}{\partial t}}{(R_t)^2}$
$= \frac{1}{(R_t)^2}\{\frac{\partial x}{\partial t}[(pf-2t)w\frac{\partial L}{\partial t} - (pf-t)\frac{\partial x}{\partial t}] - [-wx\frac{\partial L}{\partial t} - pf(wL-x)\frac{\partial x}{\partial t} + pf(wL-x)\frac{\partial^2 x}{(\partial t)^2} + wt(wL-x)\frac{\partial^2 L}{(\partial t)^2}]\}$
where $R_t = wL - x + wt\frac{\partial L}{\partial t} + (pf-t)\frac{\partial x}{\partial t}$
Given the results from section 1 that L_t and x_t cannot be compared nor signs determined, we cannot algebraically compute the size or sign of the term , $\frac{\partial}{\partial t} MCF_t$. This is also true for other MCF models.

Table 4.5: Results of Simulations of the MCF Models

MCF of tax rate	MCF of fine rate	MCF of prob	MCF of lump-sum
1.87593	1.05578	1.0803	0.3553

The initial values are selected so that simulations are robust[5]. Given this arbitrary, the absolute magnitude of the estimate is not very useful; only the relative magnitude of the estimate and the changes in MCFs are of our interest.

Simulations based on the specific utility function and the above values allow us to measure the MCF of each tax instrument: the estimates are summarized in table 4.5.

The simulations show that the MCF of tax rate is the grestest while MCFs of fine rate and probability of detection are less, as expected. The simulations indicate that the marginal cost of fine rates and probability of detection are less expensive to the society than the marginal cost of the tax rate. The MCF of lump-sum tax is the lowest and less than one. The MCF of lump-sum tax is less than one, reflecting an increase in labor supply and reported income.

Now we can estimate the changes in MCFs which result from variations in tax parameters. By varying the tax rate a bit from the bench mark, we can obtain

[5]Most values will give simulations non-robust and exhibit discontinuity. However, there are limited values that make the simulations robust. Our initial values are selected so that the simulations are robust and exhibit continuity.

the estimate signs of the changes in MCF models which result from the variation in tax rate. Repeating the procedure with the fine rate, probability of detection and lump-sum tax, we can obtain the following four results:

RESULT 5. A rise in the tax rate will increase the MCFs of tax rate, fine rate, probability of detection and lump-sum tax.

RESULT 6. A rise in the fine rate will decrease the MCFs of tax rate, fine rate and probability of detection, but increase the MCF of lump-sum tax.

RESULT 7. A rise in probability of detection will decrease the MCFs of tax rate, fine rate and probability of detection but increase the MCF of lump-sum tax.

RESULT 8. A rise in lump-sum tax will decrease the MCFs of tax rate, fine rate, probability of detection and lump-sum tax.

TABLE 4.6 summarizes the changes in MCFs which result from a rise in tax parameter

Table 4.6: Summary of the Changes in MCF Models

	parameters			
variables	*t*	f	p	T
MCF of tax rate	+	-	-	-
MCF of fine rate	+	-	-	-
MCF of prob	+	-	-	-
MCF of lump-sum	+	+	+	-

In summary, we try to answer the question: how does tax evasion affect the marginal cost of funds? The first section shows that the term, $[\frac{\partial L}{\partial i} + \frac{\partial x}{\partial i}]$ where i is tax instrument, is indeterminate in sign regardless of attitude toward risk assumptions. This result suggests that the variations in tax parameters would have indeterminate results on the MCFs and thus the introduction of tax evasion would increase, decrease or leave unchanged the cost of funds.

However with a specific utility function, penalty structure and certain assumptions, we find some conclusive results. The simulation suggests that the introduction of evasion would increase the cost of funds of the tax rate. Also because the MCF of the tax rate is the highest among all available instruments, we conclude that the tax rate is the costliest tax instrument and an increase in the tax rate would increase all MCFs. Concerning other tax instruments, excluding lump-sum tax, an increase in fine rate and probability of detection would reduce the costs of funds.

If the marginal adminstrative costs of the probability of detection, $e_p(t, p, f)$, is a constant, we can assert that the higher the administrative costs, the greater the cost of funds. This is becasue a rise in the marginal administrative costs will reduce the marginal net tax revenue while leaving the marginal welfare cost of tax unchanged; hence there will be an increase in the welfare cost per one unit of tax

revenue[6].

In the second section, we discuss one of the most misconceptions in the MCF literature; the assumption that the MCF cannot be less than one. We explain and dicuss why MCFs can be lessr than one. The logic is that given a non-optimal society, the distortionary tax exists and thus there is a room to reduce these distortions. Also, if the tax rate could induce people to work more and evade less, the cost of funds is definitely less than one.

In the next chapter, we apply the derived MCFs to the US economy and compare the results to those from the existing literature.

[6]We can complicate the problem by allowing the administrative cost funtion to be non-linear in its arguments. See literature focusing on optimal auditing such as Sanchez and Sobel (1993).

Chapter 5

EMPIRICAL ANALYSIS AND MCFs OF THE UNITED STATES

This chapter discusses the existing empirical studies of marginal cost of funds with tax evasion and then applies the models deriveed in Chapter Three to the U.S. economy. In the first section, we discuss the empirical studies of marginal cost of funds with tax evasion. Depending on the assumptions and values of parameters, MCFs can vary widely. Hence for a comparative study we impose certain assumptions while using the same values of parameters. In the second section, we apply our models to the US economy.

5.1 Existing Models of Marginal Cost of Funds

In this section we discuss the existing MCFs and provide some estimates given certain assumptions. The MCF is simply a measure of the loss in welfare required to raise an additional dollar to finance a public project. Normally, a rise in the tax rate, such as marginal income tax, is employed in order to raise such funds; hence the traditional MCF models can be called the marginal cost of funds of the income tax rate. Since there is no existing literature that estimates the MCFs of non tax rate instruments, this section will only compare MCFs of income tax

rate.

As discussed in Chapter Three, according to Ballard and Fullerton (1992) there are at least two main approaches to measure MCFs: the Pigou-Harberger-Browing and the Stiglitz-Dasgupta-Atkinson-Stern approach. In Ballard and Fullerton (1992) depending on the assumptions and parameters used, MCFs of labor tax rate can vary from less than 80 cents to more than four dollars.

In order to do a comparative study, this section uses the Stiglitz-Dasgupta-Atkinson-Stern approach with uncompensated labor elasticity. Also, we assume separable utility so that public good is not substituted for private good. For simplicity we ignore administrative costs. The traditonally accepted MCF of the income tax rate is

$$MCF_t^T = -\frac{\frac{\partial V}{\partial t}}{\frac{\partial V}{\partial I}} / \frac{\partial R}{\partial t} = \frac{wL}{wL + wt\frac{\partial L}{\partial t}} = \frac{1}{1 + \frac{t\partial L}{L\partial t}} \tag{57}$$

where $\frac{\partial V}{\partial t}$ is the welfare cost of the labor tax rate. V is indirect utility, $\frac{\partial V}{\partial I}$ is the marginal utility of income ($-V_T$ in this paper) and $\frac{\partial R}{\partial t}$ is the marginal revenue of the labor tax rate. Hence, wL is simply the indirect marginal utility loss in terms of income and $wL + wt\frac{\partial L}{\partial t}$ is the marginal revenue raised by increasing the labor tax rate, where $\frac{t\partial L}{L\partial t}$ is uncompensated labor elasticity.

According to Mayshar (1991a), allowing for tax evasion the MCF of the labor tax rate is

$$MCF_t^M = \frac{wL - x}{wL - x + wt\frac{\partial L}{\partial t} + t\frac{\partial x}{\partial t}} = \frac{1}{1 + \frac{wL}{(wL-x)}[\frac{t\partial L}{L\partial t}] - \frac{x}{(wL-x)}[\frac{t\partial x}{x\partial t}]} \tag{58}$$

where x is evasion and wL - x is reported income. Here, $[\frac{t\partial L}{L\partial t}]$ is labor supply elasticity and $[\frac{t\partial x}{x\partial t}]$ is evasion elasticity with respect to tax rate.

5.2 MCFs of the United States

In this section, we apply the models derived in Chapter Three to measure the MCFs of the US economy.

If we rewrite (34) and arrange it in terms of elasticities, the marginal cost of tax rate is:

$$MCF_t = \frac{1}{1 + \frac{wL}{(wL-x)}[\frac{t\partial L}{L\partial t}] + (\frac{pf}{t} - 1)\frac{x}{(wL-x)}[\frac{t\partial x}{x\partial t}]} \tag{59}$$

Similarly, using equation (35), the marginal cost of funds of fine rate is:

$$MCF_f = \frac{1}{\frac{pf}{t} + \frac{wL}{x}[\frac{f\partial L}{L\partial f}] + (\frac{pf}{t} - 1)[\frac{f\partial x}{x\partial f}]} \tag{60}$$

Using equation (36) and ignoring auditing costs, the marginal cost of funds of the probability of detection is:

$$MCF_p = \frac{[\frac{u(c^{1*},1-L^*)-u(c^{2*},1-L^*)}{E(u_c)}]\frac{p}{xt}}{\frac{pf}{t} + \frac{wL}{x}[\frac{p\partial L}{L\partial p}] + (\frac{pf}{t} - 1)[\frac{p\partial x}{x\partial p}]} \tag{61}$$

The following table 5.1 summarizes the values used and their sources.

Table 5.1: Data, Estimates and Sources

Variable	Value	Sources
t	0.4	Mayshar (1991a)
$\frac{x}{wL} * 100$	8%	Clotfeller (1983)
$\frac{wL}{(wL-x)} = \frac{1}{(1-0.08)}$	0.9	
p	2%	$2.9 - 1.77\%$ from W&W(1985)
f	2	the direct fine rate is 1.75
$\varepsilon_{L,t} = [\frac{t\partial L}{L\partial t}]$	0.1	Stuart and Hansson (1985)
$\varepsilon_{x,t} = [\frac{t\partial x}{x\partial t}]$	0.84	Clotfeller (1983)
$\varepsilon_{L,f} = [\frac{f\partial L}{L\partial f}]$	0	from simulation with log utility func
$\varepsilon_{x,f} = [\frac{f\partial x}{x\partial f}]$	.966	approx. 1.15 of $\varepsilon_{x,t}$
$\varepsilon_{L,p} = [\frac{p\partial L}{L\partial p}]$	0	from simulation with log utility func
$\varepsilon_{x,p} = [\frac{p\partial x}{x\partial p}]$	1.26	approx. 1.5 of $\varepsilon_{x,t}$
a	0.5% of Rev	Steuerle (1986)

The MCF of tax rate :

From (62) and the values above

$$MCF_t = \frac{1}{1 - 0.067 - (0.9)(.086)(.84)} = \frac{1}{1 - 0.067 - 0.0657} = 1.16 \tag{62}$$

and from Mayshar (1991a), the MCF of tax rate with evasion is

$$MCF_t^M = \frac{1}{1 - 0.067 - (.086)(.84)} = \frac{1}{1 - 0.067 - .073} = 1.17 \tag{63}$$

In contrast the conventional MCF of tax rate without evasion is

$$MCF_t^T = \frac{1}{1 - 0.067} = 1.0718$$

From the above estimation, the cost of evasion is calculated to be 10 and 8 cents from Mayshar's and our model respectively. The term, $(1 - \frac{pf}{t}) = (0.9)$, differentiates our model from that of Mayshar. This is because our model, with a setting under uncertainty, explicitly treats the probability of detection and fine rate. Marshar's model incorporates these two parameters into one: tax technology. The treatment of the fine rate and probability of detection is crucial since their effect, $(1 - \frac{pf}{t})$, would allow the cost of funds to change as the two tax parameters change. As the tax parameters, p and f, rise, the cost of funds falls. The evasion term, $(\frac{pf}{t} - 1)\frac{x}{(wL-x)}[\frac{t\partial x}{x\partial t}]$, gets close to zero as "pf" approaches "t".

MCF of fine rate :

From (60) and the values above

$$MCF_f = \frac{1}{0.1 - 0 + (0.9)(1.15)(.84)} = 1.03 \tag{64}$$

MCF of probability of detection :

From (61) and the values in Table 5.1 and inference from simulations.

$$MCF_p = \frac{(2)(0.625)}{0.1 - 0 + (0.9)(1.5)(.84)} = 1.012 \qquad (65)$$

5.3 Sensitivity Analysis

Sensitivity analysis exercise aims to study the robustness and applicability of the models. By changing parameter, such as tax rate, we can analyze how much sensitive the MCF models are to the parameter. The more robust or less sensitive, the more desirability of the model is.

We change parameters in the following order: tax rate, fine rate, probability of detection, labor elasticity of tax rate, evasion elasticity of tax rate, evasion elasticity of fine rate, evasion elasticity of probability of detection. The first row indicates variables. The second row is the benchmark value, similar to the value obtained from Table 5.1. The table reports only when parameters and estimates of MCFs are different from the benchmark; blank means its value is the same as the benchmark value. An asterisk * indicates that the estimate is substantially different from that of the benchmark[1].

[1] An arbitrary number 75%, less or more than that of the benchmark, is used.

Table 5.2: Results of Sensitivity Analysis

t	f	p	$\varepsilon_{L,t}$	$\varepsilon_{x,t}$	$\varepsilon_{x,f}$	$\varepsilon_{x,p}$	MCF_t	MCF_f	MCF_p
.4	2	.02	.1	.84	.966	1.26	1.16	1.030	1.012
.3							1.12	1.031	1.36
.45							1.18	1.031	0.89
.5							1.21	1.032	0.80
.6							1.3	1.0327	0.67
	1						1.16	1.033	1.00
	1.5						1.16	1.0324	1.012
	2.5						1.15	1.0306	1.018
	3						1.155	1.029	1.023
		.01					1.165	1.0333	0.501*
		.05					1.1457	1.026	2.61*
		.08					1.131	1.020	4.325*
		.1					1.122	1.017	5.53*
			.01				1.078		
			.06				1.122		
			.4				1.200		
			.6				2.00		
				.08			1.085		
				.4			1.115		
				1			1.177		
				2			1.296		
				5			1.86		
					0.02			8.47*	
					.05			6.89*	
					.5			1.81*	
					2			0.5*	
					10			0.1*	
						0.05			8.62*
						0.1			6.57*
						0.5			2.27*
						2			0.65*
						5			0.27*

The analysis suggests that the MCF of tax rate is quite robust while those of fine rate and probability of detection are not; they are especially sensitive to their own elasticities. Furthermore, the MCF of probability of detection is quite sensitive to its own parameter, the probability of detection. For example, if the evasion elasticity of fine rate is reduced to 0.05, the MCF of fine rate will increase to more than six dollars. Similarly, if the evasion elasticity of probability of detection is reduced to 0.1, its MCF will increase to more than six dollars. This points out that any attempt to use the MCFs of fine rate and probability of detection shoud be carried out with reservation. Also, the analysis suggests a further empirical study on those elasticities of fine rate and probability of detection.

In this chapter we have applied the derived models of MCFs with tax evasion to the U.S. economy and then compared them to existing models. The results indicate that evasion would significantly increase the cost of tax funds of the tax rate. The welfare cost induced by evasion is almost as large as the traditional cost, distortion from labor substitution. Also, the results suggest that Mayshar's model results in an over-estimate because it does not incorporate fine rate and probability of detection and hence does not allow the two instruments to alleviate the cost of evasion. As shown in the last chapter and empirical results, incorporating the two instruments reduces the cost of tax funds of the tax rate. Nonetheless, sensitivity analysis suggests that any attempt to use MCFs of fine rate and probability of detection shoud carry out with reservation.

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